Descriptions of the Colour Patterns of Juvenile Anemonefishes (Pomacentridae: *Amphiprion*) from New South Wales and the Lord Howe–Norfolk Island Region

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The live juvenile colour patterns of all three anemonefishes with breeding stocks in New South Wales and the Lord Howe–Norfolk Island region are described for the first time. The three species, *Amphiprion akindynos* Allen, *Amphiprion mccullochi* Whitley and *Amphiprion latezonatus* Waite had similar colour patterns consisting of a dark brown or black base colouration, three white body bars, and a yellow snout and pectoral fin tips. The colour patterns of juvenile *A. akindynos* and *A. mccullochi* were not consistently separable, whereas *A. latezonatus* Waite could be distinguished from these two species due to differences in caudal and soft dorsal fin coloration. Ontogenetic changes in colour patterns are also described.

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INTRODUCTION

The anemonefishes (Sub-family Amphiprioninae) are a guild of pomacentrid fish that are obligate symbionts of certain sea-anemone species (Allen 1975). Although the adult phase colour patterns of anemonefishes are well known and described (Allen 1975, 1980, 1991; Fautin and Allen 1992) descriptions of the live juvenile phase colouration are generally lacking, particularly for those fish occurring in eastern Australian sub-tropical waters.

The present study aimed at describing the live colour patterns of all three *Amphiprion* species that have breeding stocks within New South Wales and the Lord Howe–Norfolk Island region, as a guide for field identifications. Two species of anemonefish have breeding populations in the mainland waters of N.S.W.; the tropical *Amphiprion akindynos* and the sub-tropical endemic *A. latezonatus* (Richardson 1996; Richardson et al. 1997). Unlike *A. akindynos*, *A. latezonatus* also has breeding populations in the Lord Howe–Norfolk Island region, where it co-occurs with the regionally endemic *A. mccullochi* (Allen 1991). An additional two anemonefishes have been recorded in N.S.W. mainland waters (*A. perideraion* (Bleeker) and *A. melanopus* Bleeker; see Richardson 1996), both of which are tropical vagrants that do not have breeding stocks within the eastern Australian sub-tropics (Richardson 1996). Both of these species are well described elsewhere (see Allen 1975; 1980; 1991; Fautin and Allen 1992) and are not considered further in this study.

MATERIALS AND METHODS

Field observations and collections were undertaken at fifteen locations extending from Gneering Shoals (26°37′S, 153°07′E) in southern Queensland to South West Rocks (30°56′S, 153°05′E) in northern N.S.W. Specimens held by the Australian Museum, and colour photographs of live anemonefishes, were examined at sites extending from the Gneering Shoals to Broughton Island (32°37′S 152°18′E), and Lord Howe Island (31°33′S, 159°05′E), Norfolk Island (29°01′S, 168°03′E) and Middleton Reef (29°27′S, 159°06′E).

The two anemonefish species from mainland waters (*Amphiprion akindynos* and *A. latezonatus*) were identified by monitoring changes in the colour patterns of known individuals over time at Julian Rocks (28°36′S, 153°37′E). Three to four juveniles of each species were monitored at one to two monthly intervals over a twelve month period, after which time they had reached sub-adult status and their species membership could be determined. The results of this study were validated by monitoring the ontogenetic colour change in two aquaria-reared juveniles of each species over a fourteen month period.

Juvenile *A. mccullochi* was identified and described from photographs taken *in situ* and previous taxonomic records. Since *A. latezonatus* is the only anemonefish species sympatric with *A. mccullochi* in the Lord Howe–Norfolk Island region (Allen 1991), juveniles from this region with colour patterns unlike *A. latezonatus* were considered to be *A. mccullochi*. Furthermore, the live colour patterns of juvenile *A. mccullochi* were cross referenced to the general colour patterns of preserved specimens and previous descriptions of this species (see Whitley1929; Allen 1975).

Descriptions and line-drawings of all species were made from photographs taken in the field and laboratory aquaria, specimens collected by the author (and deposited at the Australian Museum), and other specimens held at the Australian Museum (AMS). All lengths given are standard lengths (mm).

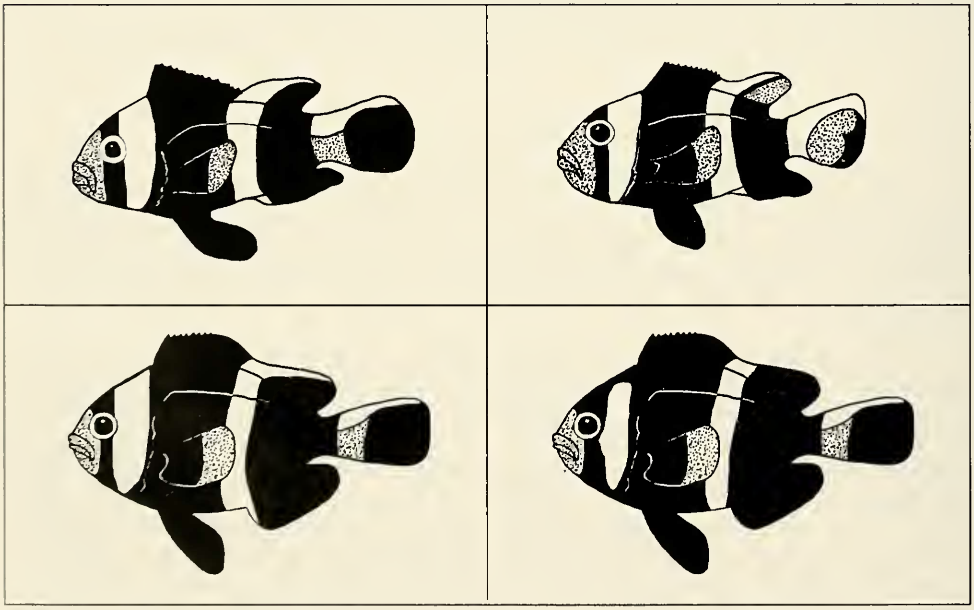

Figure 1. Juvenile colour patterns of (a) *Amphiprion akindynos*, 25 mm SL, (AMS I.37378-001, North Solitary Island); (b) *A. latezonatus*, 20 mm SL (AMS I.37378-002, North Solitary Island); (c) *A. mccullochi*, 28 mm SL (AMS IB.5497, Lord Howe Island); (d) *A. mccullochi*, 36 mm SL (AMS IA.968, Lord Howe Island). Black = black/dark brown, white = white, stippling = yellow).

DIAGNOSTICS

Generic Colour Patterns

Juveniles (i.e. post-settlement fish, varying in size from 9 to 35–40 mm SL) of all three species had a dark brown or black base colouration, with three white body bars; a white vertical head bar extending from the lower edge of the interopercule to the dorsal surface of the head, a white vertical mid-body bar and a white peduncular bar. Yellow pectoral fin pigment extended over the outer third of rays and the snout was yellow. Intra-specific variations in the colour patterns did not appear to be dependent on the anemone species inhabited.

Amphiprion akindynos (Fig. 1a)

Material Examined:

(10 preserved specimens: 13–34 mm; 11 preserved specimens: 40–97 mm). AUSTRALIA — Gneering Shoals (2: 20.0–25.5); North Solitary Island, AMS I.37378–001 (6: 13.1–19.0), (10: 40.0–97.0 mm); Broughton Island, AMS I.17246004 (2: 11.1–34.4), AMS I.37378–001 (1: 57.5). Field observations at Gneering Shoals (4: 15–25), Moreton Bay reefs (25: 10–30), Julian Rocks (>30: 10–35), North Solitary Island (>30: 10–35), and South West Rocks (6: 15–25).

Live Colour Description:

Juvenile colouration observed in specimens from 9–35 mm. Dark brown or black base colour. Head-bar usually touched the posterior edge of eye (did not touch posterior edge of eye in 2 of 10 specimens) and joined at the anterior base of the dorsal fin. Mid-body white bar usually extended over the second spine of the anal fin (1 of 10 specimens extended from just anterior of the anus), reaching over 5–6 rays of dorsal fin, and continued posteriorly along the distal edge of fin rays. The remainder of soft dorsal fin dark. The ventral half of the peduncular bar yellow; dorsal half of the peduncular bar white, with the white portion extending posteriorly along upper edge of caudal fin in 9 of 10 specimens, remainder of caudal fin dark. Yellow snout pigment touched the anterior edge of eye (just anterior of the eye in 2 of 10 specimens). Spinous dorsal fin, anal and pelvic fins dark except 14 of 90 live specimens (15–35 mm) which had yellow to light brown anal and pelvic fins.

Colour in Alcohol:

Dark brown or grey body colour and cream/grey snout, abdomen, bars and pectoral fin tips. Yellow and white pigmentation of live specimens was grey or cream in alcohol.

Ontogenetic Changes:

Brown/black base colour progressively faded to light brown/tan with increasing size, dark base colour absent in specimens >35–40 mm. Yellow snout, and caudal and pectoral fin pigmentation absent in specimens >35–45 mm, caudal fin entirely white in specimens >55 mm. In specimens > 50 mm, head bar does not join anteriorly and the mid-body bar does not touch dorsal fin, in contrast to juveniles.

Previous Literature:

Allen (1975) briefly described and illustrated a juvenile *A. akindynos* from the Great Barrier Reef. In contrast to all specimens examined in the present study, the peduncular bar of Allen's specimen (his Fig. 78) surrounded the caudal fin. Allen (1975) provided a photograph of two juvenile *A. akindynos* in an aquarium (Fig. 206); these specimens lacked yellow pigmentation on the caudal fin, in contrast to all specimens examined during the present study .

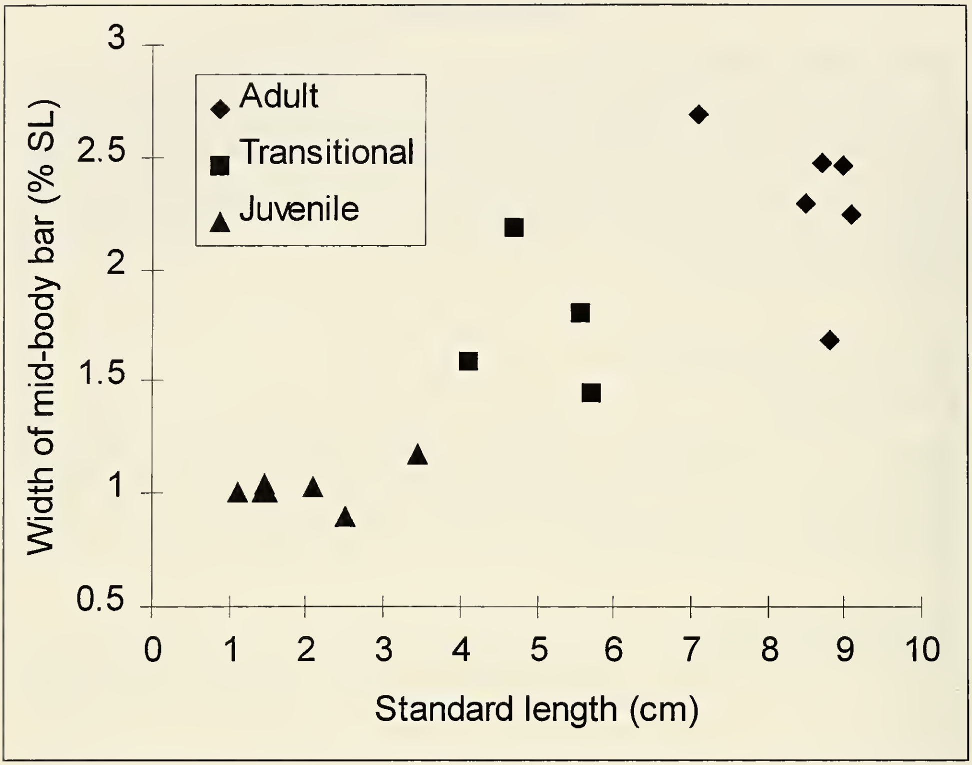

Figure 2. Relationship between mid-body bar width (expressed as a percentage of the standard length of fish) and the standard length of juvenile, sub-adult and adult *Amphiprion latezonatus* at Julian Rocks, December 1994

Remarks:

Since thorough descriptions of the live colour patterns of juvenile *A. akindynos* are lacking from the Great Barrier Reef, it is unknown whether the differences in caudal fin colouration between this study and Allen (1975) are due to geographic or random variations.

Amphiprion latezonatus (Fig. 1b)

Material Examined:

(7 preserved specimens: 11–34 mm; 11 preserved specimens: 47–91 mm). AUSTRALIA — North Solitary Island AMS I.37378–002 (7: 11.1–34.5), AMS I.19700–002 (6: 57.7–91.0); Broughton Island AMS I.17246001 (3: 41.3–71.0) . Live specimens and photographs at Lord Howe Island (1: 25), Gneering Shoals (1: 15), Moreton Reefs (1: 20), Julian Rocks (23: 15–30), North Solitary Island (18: 10–35) and South West Rocks (5: 15–20).

Live Colour Description:

Juvenile phase colouration was observed in specimens from 10–34 mm. Base colour black or dark brown. Head bar touched posterior edge of eye and joined at the anterior base of the dorsal fin (Fig. 1b). Mid-body white bar extended over the second spine of the anal fin, extending over 3–7 rays of dorsal fin, and continued posteriorly along the distal edge of fin rays. The remainder of soft dorsal fin was yellow. The peduncular bar extended ventrally across the peduncle, and along the upper margin (and posterior margin in 3 of 7 specimens) of the caudal fin. The caudal fin predominantly yellow with a surrounding black border that was more pronounced posteriorly (Fig. 1b). Yellow snout pigment touched the anterior edge of eye. Spinous dorsal fin, anal and pelvic fins dark.

Colour in Alcohol:

Dark brown to grey base colour. Yellow and white makings of live specimens were cream colour in alcohol.

Ontogenetic Changes:

Dark base colour present at all development stages. The maximum width of the mid-body bar (expressed as a percentage of standard length), a major diagnostic feature separating the colour patterns of adults from congeners, was relatively narrow in the juvenile stage but increased with increasing size (Fig. 2). In specimens >60 mm, yellow snout, and soft dorsal, caudal and pectoral fin pigmentation was absent. Specimens >45–50 mm develop a white bar on the posterior edge of the caudal fin and dark yellow pigmentation on the base of dorsal fin.

Previous Literature:

Photograph of large juvenile in Kuiter (1993).

Remarks:

The predominant yellow caudal and soft dorsal fins colouration clearly distinguish juvenile *Amphiprion latezonatus* from congeners in this geographic region.

Amphiprion mccullochi (Fig. 1c and 1d)

Material Examined:

(2 preserved specimens: 9 mm; 4 preserved specimens 28–41 mm; 1 preserved specimens 83 mm). AUSTRALIA–Lord Howe Island, AMS IA.963 (1: 83.0), AMS IA.967 (1: 43.1), AMS IA.968 (1: 36.0), AMS IB.5497 (1: 28.0), AMS I.17368038 (1: 9.0), AMS 5515 (1: 9.1); Middleton Reef, I.27142024 (1: 29.0). Photographs of live specimens — Lord Howe Island (3: ~20 mm).

Live Colour Description:

Base colour black. Snout, and head and mid-body bar width varied with size of specimens. Specimens 9–20 mm (Fig. 1c); head-bar touched the posterior edge of eye and joined at the anterior base of the dorsal fin. Mid-body white bar extended over the second anal fin spine, reaching onto first 4–5 rays of dorsal fin, and continued posteriorly along the distal edge of fin rays. Yellow snout touched anterior edge of eye. Specimens 28–43 mm (Fig. 1d): head-bar was less pronounced than in small specimens, did not join dorsally and usually did not touch eye (1: 29 mm specimen, head bar touched anterior edge of eye). Mid-body white bar extended from just anterior of the anus, reaching onto first 1–2 rays of dorsal fin, and did not continue posteriorly along the distal edge of fin rays. Yellow snout pigment touched the edge of eye in the (2) 28–29 mm specimens, but not in the (2) 36–43 mm specimens.

Soft dorsal fin dark in all juvenile specimens (9–43 mm). The ventral half of the peduncular bar yellow; dorsal half of the peduncular bar white, with white portion extending posteriorly along upper edge of caudal fin, remainder of caudal fin dark. Spinous dorsal fin, anal and pelvic fins dark.

Colour in Alcohol:

Dark brown base colour with cream bars and snout.

Ontogenetic Changes:

Dark base colour present at all development stages. Only the head bar is retained in the adult stage, and is highly reduced in width and length compared to juveniles. Specimens >44 mm: yellow snout, and yellow caudal and pectoral fin pigmentation absent; caudal fin entirely white; mid-body bar absent or highly reduced. Ontogenetic colour changes in this species have not been fully documented and requires further investigation.

Previous Literature:

Whitley's (1929) description of juvenile *A. mccullochi* and the juvenile specimen (AMS IB.5497) illustrated in Allen (1975) are in agreement with the present study.

Remarks:

The juvenile colouration of small (<20 mm) *Amphiprion mccullochi* was, in most cases, identical to juvenile *A. akindynos,* with the exception that some *A. akindynos* specimens had light brown anal and pelvic fins, whereas *A. mccullochi* did not. There were, however, some distinct differences between these two species in larger juveniles (>28 mm). In this regard, the head bars joined at the anterior base of the dorsal fin in all *A. akindynos* juvenile specimens (9–35 mm) and most sub-adult specimens (35–50 mm), but did not join in *A. mccullochi* specimens >28 mm (see also Allen 1975). Furthermore, the mid-body bars of large *A. mccullochi* juveniles (>28 mm) did not extend onto the anal fin or posteriorly along the distal edge of soft dorsal fin rays, but nearly always did in *A. akindynos* juvenile specimens (9–35 mm).

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